



CASE REPORT

# Discrepancy Between Duplex Sonography and Digital Subtraction Angiography When Investigating Extra- and Intracranial Ulcerated Plaque



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## KEY WORDS

color-coded carotid duplex sonography, digital subtraction angiography, transcranial color-coded sonography, ulcerated plaque

Noninvasive color-coded duplex sonography has become a good, convenient, and reproducible screening tool for the general population when studying cerebral hemodynamics and atherosclerotic disease. Digital subtraction angiography (DSA) is still the gold standard for the diagnosis of carotid stenosis, although other noninvasive imaging tools are also available. At present, ultrasound scanning, followed by confirmatory DSA, is a cost-effective way to survey patients suspected of suffering from cerebral arterial stenosis. We report two patients who had cerebral ischemic symptoms due to high-grade stenosis of either the cervical internal carotid artery (ICA) or the middle cerebral artery (MCA), combined with an ulcerated plaque. Ultrasonographic Doppler analysis identified high-grade stenotic lesions as marked elevations in the turbulent flow of the cervical ICA in one patient and of the middle cerebral artery in the other patient. Subsequently, huge plaque ulceration was found by color B-mode scanning of the patient with cervical ICA stenosis. However, DSA was able to demonstrate only a mild–moderate degree of stenosis associated with the lesions. High-grade stenotic lesions of the ICA and the middle cerebral artery were reconfirmed by computed tomography angiography and magnetic resonance angiography. An atheromatous plaque with ulceration is believed to be the cause of this discrepancy between ultrasonography and DSA.

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## Introduction

Carotid endarterectomy (CEA) is clinically beneficial when treating symptomatic patients with severe carotid stenosis, according to the North American Symptomatic Carotid Endarterectomy Trial and the European Carotid Surgery Trial, both of which included angiographic studies [1,2]. Carotid angioplasty with stenting provides an equivalent benefit to CEA when protecting against ipsilateral stroke in patients with symptomatic and asymptomatic carotid stenosis [3]. Conventional angiography or digital subtraction angiography (DSA) has been suggested to be useful when diagnosing and treating carotid stenosis [4]. Some authors have proposed that carotid ultrasonography alone [5,6] or carotid ultrasonography with other noninvasive image studies [7,8], such as magnetic resonance angiography (MRA) or computed tomography angiography angiography (CTA), may be sufficient prior to CEA. Nevertheless, while endovascular stenting has become the main treatment of stenotic carotid disease in Taiwan, DSA has remained the gold standard method for the diagnosis and stenting treatment of carotid stenosis. A lesion involving the presence of an ulcerated atherosclerotic plaque is believed to be a high risk factor in relation to cerebral ischemic events [9]. Plaque ulceration or intraplaque hemorrhage is a common finding in patients with ischemic symptoms. It is known that DSA has limitations when detecting plaque ulceration [10,11]. Some authors have proposed that, because DSA presents a limited number of views, this might be one of the major problems associated with DSA [12]. B-mode ultrasonography, CTA, and enhanced MRA have all recently been reported to demonstrate ulceration more accurately than DSA [11]. By contrast, some studies have disagreed with the usefulness of CTA as a detection method for plaque ulceration. The limitations of CTA are probably related to the slice thickness of the CT images [13].

Even though it is the gold standard, DSA might underestimate the degree of stenosis, particularly when there is a coexisting large ulcerated plaque. Here, we report two patients who had cerebral ischemic symptoms due to stenotic arteries, with the extracranial internal carotid artery (ICA) being affected in one individual and the intracranial middle cerebral artery (MCA) being affected in the other. Discrepancies between DSA, color-coded carotid (CCD) sonography, and transcranial duplex sonography (TCCS) were detected when evaluating the degree of arterial stenosis. The stenotic lesions were finally reconfirmed with the help of noninvasive MRA and CTA.

## Case reports

### Patient 1

A 70-year-old man was admitted to the ward owing to a sudden onset of left limb weakness. On examination, he was alert with left hemiparesis. A bruit was auscultated in the area of the right upper neck. A brain CT showed a recent infarction affecting the right frontal lobe corresponding to the territory of the right MCA. A CCD study found a segmental heteroechoic atheromatous plaque

with surface ulceration that had resulted in a 70% stenosis of the vessel diameter at the proximal portion of the right ICA. Doppler detection of the stenotic lesion revealed markedly elevated turbulent flow, with a peak systolic velocity (PSV) of  $>300$  cm/s and an end diastolic velocity (EDV) of  $>120$  cm/s (Fig. 1A). The PSV ratio of ICA to CCA on the right side was estimated to be 6 ( $>300$  cm/s:54 cm/s) and was suggestive of a  $\geq 70\%$  stenotic lesion affecting the ICA. There was also a slightly increased resistance index affecting the right common carotid artery (0.84) as compared to the left common carotid artery (0.68). The flow direction of the right ophthalmic artery was antegrade. We performed DSA in order to further identify the patient's symptomatic tight stenosis of the ICA prior to treating the patient. However, DSA simply demonstrated the presence of a narrowed lumen in the right proximal ICA with diameter stenosis of  $<50\%$ , as well as a slit-like filling defect of contrast medium across the lumen (Fig. 1B). A further CTA with thin cut images and focal reconstruction was able to document the presence of a tight stenotic atheromatous lesion in the right proximal ICA with huge plaque ulceration (Fig. 1C). His hemiparesis improved gradually after medical treatment, and he underwent successful carotid stenting for the stenotic ICA 2 months later.

### Patient 2

A 32-year-old man who had a history of hypertension was admitted to the ward due to frequent transient ischemic attack, which presented as episodic right upper limb weakness. There had been four attacks within 2 days, with the duration of each attack being about 10 minutes. The initial brain CT did not show any abnormal lesions. A CCD study only showed the presence of a mild atheromatous lesion in the area of the left CCA bifurcation. TCCS found a turbulent flow with a markedly elevated flow velocity (PSV/EDV = 373/208 cm/s) at a depth of 57 mm through left temporal window, which corresponds to the proximal portion of the left MCA and suggests a severe focal stenosis of the left MCA (Fig. 2A). MRA also demonstrated severe stenosis at the proximal part of the left MCA (Fig. 2B). MR Diffusion-weighted imaging showed the presence of multiple tiny scattered acute embolic infarcts in the area of the left MCA. An electroencephalogram revealed mild to moderate intermittent slow waves affecting the left hemisphere during a hyperventilation test, which is indicative of relative hypoperfusion of the left brain. To evaluate the possibility of treatment using intracranial stenting, DSA was performed, but it showed only mild to moderate stenosis of the left proximal MCA (Fig. 2C). No more transient ischemic attacks occurred after medical treatment, and he was discharged with antiplatelet therapy. A follow-up TCCS 6 months later showed a further increase in the flow velocities of the left MCA (PSV/EDV = 418/239 cm/s), which suggests focal tight stenosis. Further MRA also demonstrated severe stenosis in the left proximal MCA. Owing to the young age of the patient and the progression of the stenosis, notwithstanding prompt medical treatment, he was referred to a medical center and underwent successful intracranial angioplasty with stenting.

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